(NASA-CR-145977) RESEARCH IN SPACE PHYSICS AT THE UNIVERSITY OF IOWA Annual Report, 1975 (Iowa Univ.) 39 p HC $4.00 CSCL 22A

N76-14985

Unclas
G3/88 07363

RESEARCH IN SPACE PHYSICS AT THE UNIVERSITY OF IOWA

ANNUAL REPORT 1975

NGL 16-001-002

Prepared by

J. A. Van Allen
J. A. Van Allen, Carver Professor of Physics and Head, Department of Physics and Astronomy

January 1976

1.0 General Nature of the Work

1.01 Our broad objective is the extension of knowledge of the energetic particles in outer space and of their relationships to electric, magnetic, and electromagnetic fields associated with the earth, the sun, the moon, the planets, and the interplanetary medium.

1.02 Primary emphasis is (a) on observational work using a wide diversity of instruments of our own design and construction on satellites of the earth and the moon and on planetary and interplanetary spacecraft and (b) on phenomenological analysis and interpretation.

1.03 Secondary emphasis is (a) on closely related observational work by ground based radio-astronomical and optical techniques and (b) on theoretical problems in plasma physics as relevant to solar, planetary, and interplanetary phenomena.

1.04 Specific fields of current investigation are the following:

(a) All aspects of the energetic particles that are trapped in the earth's magnetic field and are transiently present in the outer magnetosphere including the magnetospheric tail of the earth; and of the solar, interplanetary, and terrestrial phenomena that are associated with these radiations -- solar flares, interplanetary magnetic fields and plasmas, aurorae, geomagnetic storms, corpuscular heating of the atmosphere, electromagnetic waves and electrostatic fields (both constant and variable) in the magnetosphere, and the ionospheric effects of particle precipitation. This field of research was originated to a major extent by this laboratory.

(b) Radio-frequency and soft X-ray emissions from both the quiescent and flaring sun and the implications thereof on the nature of the chromosphere and corona and on the acceleration and emission of energetic particles in solar flares.

(c) Energetic electrons, protons, alpha particles, and heavier nuclei emitted by the sun; the interplanetary propagation of these particles, including the effects of shock waves and the generation of electrostatic and electromagnetic waves in the interplanetary medium; and the access of such particles to the earth's magnetosphere.

(d) Solar modulation and the heliocentric radial dependence of the intensity of galactic cosmic rays.

(e) Studies of the magnetospheres of Jupiter, Saturn, and the other outer planets.

(f) Origin and propagation of very low frequency radio waves in the earth's magnetosphere and ionosphere.

(g) Shock waves in the interplanetary medium.

(h) The theory of wave phenomena in turbulent plasmas including the interplanetary medium and of the origin of super-thermal particles.

(i) Dekametric radio emissions from Jupiter and the relationships of same to its magnetosphere.

(j) Electron density distribution in the solar corona by study of the annual solar-coronal occultation of the Crab pulsar NP 0531 + 21.

(κ) Radio astronomical study of pulsars, flare stars, and other stellar sources as an extension of our work on planetary magnetospheres and the sun.

2.0 Currently Active Projects

2.01 Hawkeye I (Explorer 52, 1974-040A)

This magnetospheric satellite was designed and built at the University of Iowa with NASA support. It was launched successfully by a five-stage Scout from the Western Test Range on 3 June 1974 and injected into an eccentric, polar orbit with initial perigee at an altitude of 470 km over Antarctica. The mass of Hawkeye I is 26.63 kg; it is spin stabilized with a rotational period of about 11.0 sec. From the time of initial in-flight deployment of booms and antennas through the latest available determination (end of September 1975) the spin axis has been inertially stable at right ascension 299°.4 (± 1°.1) and declination +8.6 (± 1°.5). Orbital elements as of 13 December 1975 are as follows:

$$
\begin{aligned}
a &= 70{,}076 \text{ km} \\
e &= 0.8481 \\
P &= 51.28 \text{ hours} \\
i &= 88^\circ\!.67 \\
\Omega &= 288^\circ\!.14 \\
\omega &= 254^\circ\!.5
\end{aligned}
$$

referenced to the vernal equinox and the plane of the earth's equator. Reentry into the earth's atmosphere is predicted for late April 1978.

All antennas and booms were deployed successfully and all scientific instruments and spacecraft subsystems and systems continue to operate perfectly after 19 months in orbit, with two relatively minor exceptions. The command circuit for actuating the optical aspect device ceased functioning on 6 September 1974. The loss of this element makes the measurement of angular distributions more difficult. However, the orientation of the spin axis, the spin period, and the roll phase are now determined routinely and accurately along segments of the orbit in which the scalar magnetic field exceeds 200 gammas by comparison of the measured magnetic vector with the GSFC model field. Along other segments of the orbit the solar ultra-violet pulses in the electrostatic particle analyzer give a good determination of the spin period and the roll phase for about 3 months out of each 6. The second minor failure has been unreliable performance of the G.M. tube, which is an ancillary part of the electrostatic analyzer.

The satellite carries three basic scientific instruments for the investigation of energetic particles and electric and magnetic fields in the magnetosphere and the solar wind. Emphasis is on the "polar cusp" region of the earth's magnetosphere at high altitudes:

(a) A four-range, three-axis Schonstedt flux-gate magnetometer to measure the vector magnetic field. Full scale ranges on each axis are as follows: ± 150 gammas, ± 450 gammas, ± 1,500 gammas, and ± 25,000 gammas -- selectable by ground command.

(b) A Low-Energy Proton and Electron Differential Electrostatic Analyzer (LEPEDEA) to measure the differential energy spectra and angular distributions of protons and electrons, separately and simultaneously, over the energy range 50 to 40,000 eV for a wide range of intensities; and a thin window Geiger-Mueller tube to measure the integral intensities of $\geq$ 45 keV electrons and/or > 600 keV protons.

(c) Extremely Low Frequency/Very Low Frequency Electric and Magnetic Field receivers to study the occurrence, characteristics, and origin of naturally occurring radio noises and plasma instabilities in the solar wind, in the earth's polar magnetosphere and magnetosheath, and in other regions of the magnetosphere. The electric antenna (42 m. tip-to-tip) and associated receiver operate over a frequency range 1 Hz to 200 kHz. The magnetic antenna (a search coil magnetometer) and its associated receiver cover the frequency range 1 Hz to 10 kHz.

Command and control of the spacecraft are exercised almost exclusively from Iowa City via the U. of Iowa/ONR North Liberty Radio Observatory. NLRO also serves as the principal facility for in-flight data acquisition using the 60-ft. antenna there. Data are transmitted by microwave link to the Univac 418 computers in the Physics Building on the campus and digitized in real time. Data from southern hemisphere receiving stations of NASA are also obtained and integrated with the NLRO data on an off-line basis.

The entire data acquisition and reduction system is operating very well and setting a new standard for the efficient and rapid handling of data from a satellite. During the period 3 June 1974 to 22 July 1975, telemetry reception was achieved for nearly 90% of real time. Since that time, the acquisition and reduction of data have been cut back to about 50% because of the reduced NASA support. Scheduling is in accordance with the preferences of the scientific investigators, within relevant constraints.

In late November 1975, Hawkeye I was used in support of two barium-cloud-release rocket firings in the Arctic by the Los Alamos Scientific Laboratory (Project Periquito). The Hawkeye I data were monitored and relayed to LASL in real-time as a partial basis for a decision as to whether or not magnetospheric conditions were suitable for the rocket flights.

At present, data acquisition from Hawkeye I is scheduled to be terminated on 30 June 1976, despite the unique value of its high altitude polar data to the International Magnetospheric Study (1976-1977), with only six months overlap with the IMS. The Special Committee on Solar-Terrestrial Physics of ICSU advocates continuation of Hawkeye I beyond 20 June 1976, but no assurance of the necessary support is yet available.

Both scientifically and operational, Hawkeye I is the major current project of the University of Iowa laboratory.

(Hardware support by the Langley Research Center/NASA)

(Post-launch data acquisition, spacecraft operations, and macro data reduction support by Goddard Space Flight Center/NASA and Office of Naval Research)

(Micro-data reduction, scientific analysis, and publication support by Langley Research Center/NASA)

[Van Allen, Frank, Gurnett, Rogers, Enemark, Ackerson, Kurth, Kintner, Craven, Randall, Saflekos, Chen, Dunlavy, Brechwald, Jagnow]

2.02 Pioneers 10 and 11

University of Iowa experiments have obtained detailed data on the absolute intensities, energy spectra, and angular distributions of energetic electrons and protons in the magnetosphere of Jupiter with instruments on the two Ames Research Center/NASA spacecraft Pioneers 10 and 11. The first of these flew by Jupiter in the prograde sense during November-December 1973 with a radial distance of closest approach of 2.84 $R_{♃}$ on 4 December; the second in the retrograde sense during November-December 1974 with a radial distance of closest approach of 2.84 $R_{♃}$ on 3 December. These missions have provided the first in situ observations of energetic particles in the Jovian radiation belts, whose existence was established about 16 years ago by observation of non-thermal radio emission in the decimetric range. The magnetosphere of Jupiter is found to be generally analogous to that of Earth but exhibits several distinctive differences:

(a) An enormous magnetodisc of plasma and energetic particles, approximately in the magnetic equatorial plane of the planet, with a diameter of about 20 million kilometers (subtends 2° from the earth at opposition);

(b) Far greater intensities of high energy particles trapped in the magnetic field of the planet (magnetic moment 1.8×10^4 times that of Earth);

(c) Important particle sweeping, and perhaps particle injection, effects of the four inner satellites JIII, JII, JI, and JV; and

(d) Emission of energetic particles into the interplanetary medium.

Six major papers on Pioneer 10 and 11 results have been published and four more are in press at present.

[Van Allen, R. Randall, B. A. Randall, Thomsen, Sentman, Goertz, Pesses]

Measurements of the galactic cosmic ray intensity to over 5 AU are summarized in a current paper in press in the Astrophysical Journal. The radial gradient of intensity of protons of energy greater than 80 MeV is 0 ± 2% per AU. This result is forcing a reconsideration of previous theories of this effect which have predicted a gradient of the order of +5 to 10% per AU.

[Van Allen and Thomsen]

Other Pioneer 10/11 studies are underway on the propagation of energetic electrons and protons emitted by the sun and of those emitted by Jupiter.

[Pesses and Van Allen]

The Pioneer 10 data on the distribution of plasma in the Jovian magnetosphere as obtained by the Ames Research Center plasma analyzer have been reduced and interpreted by co-investigators at the University of Iowa.

[Frank and Ackerson]

University of Iowa instruments on both Pioneers 10 and 11 continue to operate properly. Pioneer 10 passed through a heliocentric radial distance of 9.0 AU on 6 January 1976 on its escape trajectory from the solar system. Its asymptotic escape rate is 2.4 AU per year. It is reasonable to expect continuing data acquisition to at least 20 AU (October 1979). Pioneer 11 is now targeted for an encounter with Saturn on 1 September 1979. If it continues to operate properly, it will provide the first in situ investigation of the magnetosphere of Saturn as well as of other properties of the planet, its rings and satellites.

(Support by Ames Research Center/NASA and by
Office of Naval Research)

2.03 Explorers 33 and 35

In-flight operation of Explorer 33 (in eccentric earth orbit) was terminated on 1 November 1971 after 5 years 4 months in orbit.

In-flight operation of Explorer 35 (in lunar orbit) was terminated on 24 June 1973 after 5 years 11 months in orbit.

The body of data from Explorers 33 and 35 continues to be a valuable one for study of (a) solar protons, electrons, alpha particles, and Z > 2 nuclei, (b) particle bombardment of the moon and the production of short-lived radioisotopes in the lunar surface material, (c) solar X rays and their effects on the earth's ionosphere, (d) the magnetospheric tail, (e) shock waves in the interplanetary medium and the effect of same on energetic particles, (f) access of solar particles into the magnetosphere, and (g) the solar-cycle modulation of galactic cosmic ray intensity.

During the first 14 months of the flight of Pioneer 10, Explorer 35 provided basic data on galactic cosmic ray intensity at 1 AU for comparison with that measured by Pioneer 10 over the heliocentric radial range 1.0 to 4.05 AU.

(Data reduction, analysis, and publication since 1968 supported by Office of Naval Research)

[Van Allen, Shawhan, Saflekos, Spangler, and Randall at University of Iowa; Krimigis and Sarris at Applied Physics Laboratory of Johns Hopkins University]

2.04 Explorer 43 (IMP-I)(1971-019A)

This 635-pound GSFC/NASA spacecraft was launched on 13 March 1971 into an earth orbit with initial inclination 29°, perigee altitude 234 km, and apogee at 31 earth radii. A large array of instruments was intended principally for investigation of phenomena of the outer magnetosphere. Two University of Iowa instruments yielded very good observations during an extended period of data acquisition. These instruments are a high-dynamic-range set of very low frequency radio receivers and antennae and an electrostatic analyzer for the observation of protons and electrons in the energy range from a few eV to several tens of kiloelectron volts. The spacecraft reentered the earth's atmosphere on 2 October 1974. Active analysis of the data continues.

(Support jointly by GSFC/NASA, ONR, and NASA Headquarters)

[Gurnett, Anderson, and Shaw on VLF Radio Experiment]

[Frank and Yeager on Low Energy Particle Experiment]

2.05 Small Scientific Satellite (S^3-A) (Explorer 45)(1971-096A)

This GSFC/NASA satellite was launched at 05^h UT on 15 November 1971 from the San Marco launching facility (Italian) off the coast of Kenya. The initial orbit had an inclination of 3.5°, a perigee altitude of about 350 km, a radial distance to apogee of 7.3 R_E (earth radii), and a period of 8.6 hours. The principal objective of this mission was to study the physics of the terrestrial ring current and magnetic storms. One of the instruments on board was developed by the VLF radio group at the University of Iowa in collaboration with corresponding groups at the University of Minnesota and the Goddard Space Flight Center. This instrument performed properly throughout the mission.

A number of important new results on the plasmasphere of the earth have been obtained. Data acquisition was terminated on 30 September 1974. Analysis is continuing.

(Support by GSFC/NASA)

[Gurnett, Anderson, and Shaw]

2.06 <u>British-American Near Earth Satellite (UK-4)(Ariel 4)(1971-109A)</u>

This satellite was launched on a 4-stage Scout vehicle from Vandenburg Air Force Base in California at 20:47 UT on 11 December 1971. The initial orbit had perigee altitude of 472 km, apogee altitude of 587 km, inclination of 85°, and period of 95.5 minutes. Acquisition of data was terminated some time ago.

Low energy particle measurements were made with an electrostatic analyzer system similar to that on Injun V. Emphasis was on the measurement of angular distributions of trapped and precipitating particles in the auroral zone.

A good body of flight data is on hand. Two papers have been published. Cooperative work with British investigators having other experiments on UK-4 is proving to be fruitful.

(Support by GSFC/NASA and NASA Headquarters)

[Frank and Craven]

2.07 <u>Explorer 47 (IMP-H)(1972-73A)</u>

This GSFC/NASA satellite of the earth was launched on 23 September 1972 into a near-circular orbit of inclination 17° and radius about 35 R_E (earth radii). It carries a University of

Iowa electrostatic analyzer for low energy particle measurements in the outer magnetosphere, in the magnetotail, and in the interplanetary medium. Emphasis is on accurate spectra and angular distributions of both protons and electrons. It is planned to continue data acquisition through 30 June 1976, at least.

(Support by GSFC/NASA)

[Frank et al.]

2.08 Explorer 50 (IMP-J)(1973-78A)

This 817 lb. GSFC/NASA satellite was launched on 26 October 1973 into an orbit with inclination 28°2 radial distances to perigee and apogee 23.8 and 46.4 R_E, respectively, and period 12.2 days. This satellite carries VLF radio receivers and electrostatic particle analyzers from the University of Iowa. A large body of high quality data from both sets of experiments has been acquired, with operations scheduled to continue through 30 June 1976, at least.

(Support by GSFC/NASA)

[Frank et al. on electrostatic analyzers]

[Gurnett et al. on VLF radio receivers]

2.09 German American Solar Probes (HELIOS-A and B)

The interplanetary spacecraft HELIOS-I was launched successfully from Cape Canaveral on 10 December 1974 by a Titan Centaur vehicle. The heliocentric trajectory is near the ecliptic plane with perihelion at 0.3 AU from the sun. The spacecraft passed through perihelion on 15 March 1975 and again on 21 September 1975. The next perihelion passage will be on 30 March 1976. The principal scientific purposes of the two missions are study of particle and field phenomena in the interplanetary medium at distances closer to the sun than have been reached previously. (The perihelion of Mariner 10's orbit was approximately at the orbit of Mercury at 0.39 AU.) One of the three American instruments on HELIOS is the University of Iowa plasma-radio wave receiver (10 Hz to 15 kHz).

HELIOS-I has been generally successful though one of the two deployable electric antennas on the spacecraft jammed in a partly extended state and was grounded to the spacecraft structure. This fault has resulted in substantial degradation of the University of Iowa's plasma-wave experiment, though the problems have been alleviated somewhat by operating instruments in alternating fashion and by other work-arounds.

HELIOS-B is scheduled for a 15 January 1976 launch.

(Support by GSFC/NASA)

[Gurnett, Anderson, and Odem]

2.10 International Sun Earth Explorer (ISEE)

Two University of Iowa experiments were selected for this "mother-daughter" magnetospheric mission (formerly called International Magnetospheric Explorers). Launch is planned for 1977-78. The two spacecraft in this mission will be placed in essentially identical orbits with active stationkeeping to maintain the desired physical separation. The special objective of ISEE is to separate spatial from temporal variations in transient magnetospheric phenomena. Following over a year of detailed scientific and instrumental definition work, both sets of instruments are now well into the construction phase.

(Developmental support by ONR and NASA Headquarters)

(Hardware support by GSFC/NASA)

[Low energy particle experiment -- Frank et al.]

[Plasma-wave experiment -- Gurnett et al.]

2.11 Mariner Jupiter/Saturn

The University of Iowa is a member of the plasma-wave team for an experiment on this planetary fly-by mission. Two missions are planned with launches in August-September 1977; fly-bys of Jupiter, April-May 1979; and fly-bys of Saturn, February-May 1981. The plasma wave instrument is being designed and built at the University of Iowa. The initial instrument is in an advanced stage of construction and testing. One of these missions may be retargeted after its Saturn encounter to continue to Uranus.

(Developmental support by ONR and NASA Headquarters)

(Hardware support by Jet Propulsion Laboratory/NASA)

[Gurnett, R. Randall, and Shaw]

2.12 Theory

Theoretical stdies are continuing on the propagation of solar protons, alpha particles, and electrons in interplanetary space; on the emission of X rays and radio noise by the sun; on the generation and propagation of very low frequency radio waves in the magnetosphere and on the relationship of such waves to particle acceleration, diffusion, and precipitation; on shock waves in the interplanetary medium; and on the radiation belts of Jupiter and Saturn.

(Support by ONR and NASA Headquarters)

[Gurnett, Shawhan, and Goertz]

2.13 Very-Long-Baseline Radio-Interferometry

A program of VLBI observations is being developed at NLRO in collaboration with Iowa State University/Ames, NOAA/Boulder, GSFC, and the National Radio Observatory in Greenbank, West Virginia. In contrast to most other VLBI experiments, a low frequency, 26.5 MHz, has been selected in order to study the dekametric emissions from Jupiter and the structure of the interplanetary plasma and to search for dekametric emissions from Saturn.

It is now being planned to convert the NLRO 60-foot dish to a VLBI receiving station at a wavelength of 18 cm, after termination of Hawkeye I data acquisition. Tests are in progress to determine the quality of the reflecting surface at that wavelength. If the quality is satisfactory or can be made so with reasonable effort, NLRO will become the midwestern element of a national VLBI network.

(Support by NASA, ONR, NOAA, and NSF)

[Shawhan, Cronyn, Mutel et al.]

2.14 Large Area Radio Interferometer

During 1972-74 the University of Iowa collaborated with NOAA/Boulder and GSFC in constructing the largest area radio interferometer in the northern hemisphere. Both effective area and angular resolution exceed those of the Arecibo facility. The array is located at Clark Lake, California. The operating frequency is 34 MHz. An intensive program of observations is underway. Objectives of this array are to study the propagation of solar wind streams through interplanetary space (via interplanetary scintillation of compact radio sources); to observe dekametric radio emissions from Jupiter; and to search for dekametric radio emissions from Saturn.

(Support by NASA, NSF, GSFC/NASA, and NOAA)

[Shawhan, Cronyn, Erskine, Benson et al.]

2.15 Hawkeye II Proposal

After several months of work during the summer and autumn of 1974, a major proposal was submitted to NASA on 5 November 1974 for a Hawkeye/Auroral Physics Explorer mission.

This proposal describes plans for the design, construction, testing, and launch of a spacecraft and a full complement of scientific instruments, together with the reduction and analysis of flight data and the publication of results therefrom. The principal scientific objective is to advance the understanding of the complex plasma physical phenomena in the earth's magnetosphere that cause the acceleration of charged particles and the production of the polar aurorae. Comprehensive measurements of basic plasma parameters will be made point-by-point along the orbit; in addition, broad scale imaging of auroral emissions in the upper atmosphere will be done in several spectral regions and the two bodies of data will be combined in a composite interpretation.

For these purposes a closely integrated set of eight scientific instruments is proposed. It is found feasible to incorporate this set of instruments within a spacecraft of gross mass 47.5 kg. Such a spacecraft can be launched by a four-stage Scout vehicle from the Western Test Range into the desired orbit about the earth having the initial parameters $a = 2.5086\ R_E$, $e = 0.58125$, $i = 75°$, $\omega_o = 225°$, $P = 5.595$ hours.

Our Hawkeye II proposal is still under review by NASA Headquarters, 14 months after submission, and no formal response has been received. An indication has been given that the proposal was rated highly both scientifically and technically and that a study of the relationship of such a mission to the Electrodynamics Explorer program may be authorized.

If the Hawkeye II program is approved, it will become the major developmental work of the laboratory for several years. A launch in late 1978 was envisioned in the original proposal as a realistic one. The present situation suggests that at least one to two years must be added to that target date.

The spacecraft engineering and technical staff of the laboratory will be progressively reduced and the relevant laboratory facilities will be converted to other uses if authorization and funding for Hawkeye II are not received within the next month or two.

(Phase A proposal, engineering design, and breadboarding support by ONR and NASA Headquarters)

[Van Allen, Frank, Gurnett, Shawhan, Enemark, Craven, Ackerson, Carpenter, Brechwald, Rogers, R. Randall, B. A. Randall, Jagnow, Anderson, and France, all of the University of Iowa; Hanson, Hoffman, Lippincott, and Zuccaro of the University of Texas, Dallas; and Carovillano and Eather of Boston College]

2.16 Electrodynamics Explorer Program

This NASA program (E.E.) envisions a coordinated pair of orbiting spacecraft, one in an eccentric orbit similar to that proposed for Hawkeye II, another in a circular low-altitude polar orbit. One or both may have orbital adjustment capability. The central theme of the E.E. program is study of the physical coupling of the magnetosphere, ionosphere, and neutral atmosphere of the earth. Based on proposals submitted in November 1974, two University of Iowa experiments for E.E. have been selected for further study. One of these is a set of auroral imaging instruments and the other a set of plasma-wave ELF-VLF receivers. Both are similar to those proposed for Hawkeye II. The proposers are members of the study team which is engaged in further definition of scientific objectives, spacecraft and mission design, and instrument complement. Our understanding is that authorization for the E.E. program will be sought by NASA as part of its FY 1977 budget askings, to be submitted to the Congress in late January 1976. If approved and funded by Congress, the schedule that is envisioned is approximately as follows:

(a) Support for finally selected experiments to begin no sooner than October 1977.

(b) Launch ≈ March 1980.

(Proposal and engineering design support by ONR and NASA Headquarters)

[Frank, Ackerson, and Callahan, auroral imaging]

[Shawhan et al., plasma wave experiment]

2.17 Auroral Imaging

During the past two years a major effort has been devoted to developing a new type of sensitive spot-scanning "camera" for broad scale imaging of auroral emissions and other low-light-level emissions in selected wavelength bands from the earth's atmosphere. This work has included the outfitting of an optics research laboratory; the purchase and development of suitable sources; the construction and testing of prototype systems; and development of computerized handling of imaging data. Such a system is suitable for Hawkeye II and the Electrodynamics Explorer. It is also applicable to other spinning spacecraft such as a Pioneer class spacecraft during planetary fly-bys or in planetary orbits.

(Developmental work supported by Office of Naval Research)

[Frank, Ackerson, and Callahan]

2.18 Mariner Jupiter/Uranus Proposal

During the spring and summer of 1975, the University of Iowa energetic particles group joined with corresponding groups at the California Institute of Technology, the Goddard Space Flight Center, and the University of New Hampshire in preparing and submitting a major proposal for an experiment on the NASA-announced Mariner Jupiter Uranus 1979 mission.

The mission was subsequently cancelled.

(Proposal work supported by ONR and NASA Headquarters)

[Van Allen, B. A. Randall, and R. Randall]

2.19 Advisory Work

Van Allen served as U.S.-chairman of a joint U.S.-E.S.A. mission definition group for a planned Pioneer Jupiter Orbiter/Probe mission. This report was prepared and the description of the mission was presented to a number of NASA and other advisory groups.

The mission was subsequently cancelled.

During the past year, Van Allen also served as a member of the Committee on Planetary and Lunar Exploration of the Space Science Board of the National Academy of Sciences and contributed to the development of a future national program in these areas.

3.0 Senior Academic Staff in Space Physics
[31 December 1975]

Van Allen, James A.	Carver Professor of Physics and Head of Department of Physics and Astronomy
Frank, Louis A.	Professor of Physics
Gurnett, Donald A.	Professor of Physics [On leave 1975-76]
Shawhan, Stanley D.	Associate Professor of Physics
Goertz, C. K.	Assistant Professor of Physics
Ackerson, Kent L.	Associate Research Scientist [Research Associate]
Craven, John D.	Associate Research Scientist [Research Associate]
Nicolaos A. Saflekos	Assistant Research Scientist [Research Associate]
Spangler, Steven R.	Assistant Research Scientist [Research Associate]
Kintner, Paul M.	Research Investigator [Research Associate]

Also in closely related work
(astronomy and plasma physics)

Montgomery, David C.	Professor of Physics
Knorr, Georg	Professor of Physics [On leave 1975-76]
Hershkowitz, Noah	Associate Professor of Physics
Joyce, Glenn R.	Associate Professor of Physics
Neff, John S.	Associate Professor of Astronomy

Senior Academic Staff in Closely Related Work (cont.)

Fix, John D.	Associate Professor of Astronomy
Mutel, Robert L.	Assistant Professor of Astronomy
Salu, Yehuda	Visiting Assistant Research Physicist

4.0 Senior Engineering and Administrative Staff
[31 December 1975]

Enemark, Donald C.	Adjunct Associate Professor
Brechwald, Robert L.	Manager, Systems and Programming Services
Rogers, John E.	Senior Engineer [Project Manager]
Robertson, Thomas D.	Contracts Administrator
Yeager, David M.	Senior Research Assistant
Anderson, Roger R.	Research Assistant III
Owens, Harry	Research Assistant III
Odem, Daniel L.	Engineer IV
Randall, Roger F.	Engineer IV
Shaw, Robert R.	Engineer IV
Anderson, R. D.	Engineer III
Baker, Keith R.	Engineer III
Clark, Scott A.	Engineer III [On Leave of Absence]
English, Michael	Engineer III
Jagnow, Paul G.	Engineer III
Kruse, Elwood A.	Engineer III [R and QA]
Remington, Steve L.	Engineer III
Phillips, James R.	Engineer III
Freund, Edmund A.	Supervisor, Technical Services [Departmental Machine Shop]
Robison, Evelyn D.	Project Assistant [Supervisor, Publications]
Davison, W. Rollin	Computer Operations Manager

Senior Engineering and Administrative Staff (cont.)

Dunlavy, D. David	Engineer II: Station Manager North Liberty Radio Observatory
Fliehler, Robert	Engineer I: Hawkeye Magnetometer
France, Richard J.	Senior Programmer Analyst
Shore, Kerry M.	Programmer Analyst
Callahan, Timothy J.	Research Assistant II/EPS

5.0 Junior Academic Staff in Space Physics [31 December 1975]

All of those listed below are graduate students, engaged in research in space physics.

	Appointment	Principal Research Project
Anderson, Roger R.	Research Assistant III	VLF Radio (S^3-A), HELIOS
Baumback, Mark M.	Research Assistant	VLF Radio (IMP-J)(Hawkeye)
Benson, John C.	Research Assistant	Large Area Radio Interferometer
Burek, Barbara G.	Research Assistant	Auroral Imaging
Chen, Henry Sha-Lin	Research Assistant	Solar Radio Emissions
Chen, Tsan-fu	Research Assistant	Magnetic Fields (Hawkeye)
DeCoster, Richard	Research Assistant	Magnetospheric Physics
Erskine, Fred T.	Research Assistant	Large Area Radio Interferometer
Green, James L.	Research Assistant	Radio Astronomy
Hodges, Mark W.	Teaching Assistant	Radio Astronomy
Johnson, Jeffrey A.	Teaching Assistant	Radio Astronomy
Kurth, William S.	Research Assistant	VLF Radio (Hawkeye)
Lee, James A.	Research Assistant	Electrostatic Analyzers
Murphy, Gerald B.	Teaching Assistant	Radio Astronomy
Pesses, Mark E.	Research Assistant	Pioneer 10/11

Junior Academic Staff in Space Physics (cont.)

	Appointment	Principal Research Project
Sentman, Davis D.	Research Assistant	Pioneer 10/11
Thomsen, Michelle N.	Research Assistant	Pioneer 10/11
Weisberg, Joel M.	Research Assistant and Link Foundation Fellow	Radio Astronomy (Arecibo)
Yeager, David M.	Senior Research Assistant	Magnetospheric Particles (UK-4, IMP-I, H, and J)

6.0 Advanced Degrees Awarded in Space Physics at U. of Iowa 1 October 1974 -- 31 December 1975

M.S. Degree

William S. Kurth (May 1975), "Direction Finding Measurements of Auroral Kilometric Radiation"

Joel M. Weisberg (May 1975), "The 1973 Solar Occultation of the Crab Nebula Pulsar"

Ph.D. Degree

Daniel N. Baker (December 1974), "Energetic Particle Fluxes and Spectra in the Jovian Magnetosphere"

Nicolaos A. Saflekos (July 1975), "Entry of Low-Energy Solar Protons into the Earth's Magnetotail"

Robert R. Shaw (July 1975), "Electrostatic Noise Bands Associated with the Electron Gyrofrequency and Plasma Frequency in the Outer Magnetosphere"

Steven R. Spangler (July 1975), "Radioastronomical Observation of UV Ceti Stars"

David M. Yeager (December 1975), "Variations of Low-Energy Electron Intensities in the Distant Polar Magnetosphere Associated with Interplanetary Sector Structure"

7.0 Research Reports and Publications in Space Physics 1 October 1974 -- 31 December 1975

E. T. SARRIS and J. A. VAN ALLEN
Effects of Interplanetary Shock Waves on Energetic Charged Particles
J. Geophys. Res., 79, 4157-4173, 1974

DONALD A. GURNETT
The Earth as a Radio Source: Terrestrial Kilometric Radiation
J. Geophys. Res., 79, 4227-4238, 1974

C. K. GOERTZ
Polarization of Jovian Decametric Radiation
Planetary and Space Science, 22, 1491-1500, 1974

B. A. RANDALL
Pioneer X: Observations of Energetic Electrons in the Jovian Magnetosphere
The Magnetospheres of Earth and Jupiter, ed. by V. Formisano, Proceedings, Neil Brice Memorial Symposium on Magnetospheres, Frascati, Italy, May 28 -- June 1, 1974 (Amsterdam: D. Reidel Co., 1974), pp. 355-373

STANLEY D. SHAWHAN, CHRISTOPH K. GOERTZ, RICHARD F. HUBBARD, DONALD A. GURNETT, and GLEN JOYCE
Io-Accelerated Electrons and Ions
The Magnetospheres of Earth and Jupiter, ed. by V. Formisano, Proceedings, Neil Brice Memorial Symposium on Magnetospheres, Frascati, Italy, May 28 -- June 1, 1974 (Amsterdam: D. Reidel Co., 1974), pp. 375-389

PAUL RODRIGUEZ and DONALD A. GURNETT
Electrostatic and Electromagnetic Turbulence Associated with the Earth's Bow Shock
J. Geophys. Res., 80, 19-31, 1975

J. A. VAN ALLEN
Investigation of Uranus, Its Satellites, and Distant Interplanetary Phenomena by Spacecraft Techniques
Icarus, 24, 277-279, 1975

J. A. VAN ALLEN, B. A. RANDALL, D. N. BAKER, C. K. GOERTZ, D. D. SENTMAN, M. F. THOMSEN, and H. R. FLINDT
Pioneer 11 Observations of Energetic Particles in the Jovian Magnetosphere
Science, 188, 459-462, 1975

J. D. CRAVEN and L. A. FRANK
Observations of Angular Distributions of Low Energy Electron Intensities over the Auroral Zones with Ariel 4
Proc. R. Soc. Lond. A., 343, 167-188, 1975

DONALD A. GURNETT
The Earth as a Radio Source: The Nonthermal Continuum
J. Geophys. Res., 80, 2751-2763, 1975

WILLIAM S. KURTH, MARK M. BAUMBACK, and DONALD A. GURNETT
Direction-Finding Measurements of Auroral Kilometric Radiation
J. Geophys. Res., 80, 2764-2770, 1975

L. A. FRANK
Magnetospheric and Auroral Plasmas: A Short Survey of Progress, 1971-1975
Rev. Geophys. and Space Physics, 13, 974-989, 1975

M. E. PESSES and E. T. SARRIS
On the Anisotropies of Interplanetary Low-Energy Proton Intensities
Geophys. Res. Letters, 2, 349-352, 1975

JAMES A. VAN ALLEN
Interplanetary Particles and Fields
Scientific American, 233, 160-173, 1975

D. D. SENTMAN, J. A. VAN ALLEN, and C. K. GOERTZ
Recirculation of Energetic Particles in Jupiter's Magnetosphere
Geophys. Res. Letters, 2, 465-468, 1975

ROBERT R. SHAW and DONALD A. GURNETT
Electrostatic Noise Bands Associated with the Electron Gyrofrequency and Plasma Frequency in the Outer Magnetosphere
J. Geophys. Res., 80, 4259-4271, 1975

EMMANUEL T. SARRIS
On the Acceleration of Cosmic Rays
Astrophysics and Space Science, 36, 467-472, 1975

W. M. CRONYN, S. D. SHAWHAN, F. T. ERSKINE, A. H. HUNEKE, and D. G. MITCHELL
Interplanetary Scintillation Observations with the Cocoa Cross Radio Telescope
U. of Iowa 75-1
J. Geophys. Res. [1976]

D. D. SENTMAN and J. A. VAN ALLEN
Angular Distributions of Electrons of Energy $E_e > 0.06$ MeV in the Jovian Magnetosphere
U. of Iowa 75-3
J. Geophys. Res. [1976]

L. A. FRANK, K. L. ACKERSON, J. H. WOLFE, and J. D. MIHALOV
Observations of Plasmas in the Jovian Magnetosphere
U. of Iowa 75-5
J. Geophys. Res. [1976]

J. A. VAN ALLEN, B. A. RANDALL, D. N. BAKER, C. K. GOERTZ, D. D. SENTMAN, M. F. THOMSEN, and H. R. FLINDT
Pioneer 11 Observations of Energetic Particles in the Jovian Magnetosphere
U. of Iowa 75-9

WILLARD M. CRONYN and STANLEY D. SHAWHAN
A Decametric Wavelength Radio Telescope for Interplanetary Scintillation Observations
U. of Iowa 75-12 [Revision July 1975]

D. N. BAKER and J. A. VAN ALLEN
Energetic Electrons in the Jovian Magnetosphere
U. of Iowa 75-13
J. Geophys. Res. [1976]

JOEL M. WEISBERG [Extension of M.S. Thesis, May 1975]
The 1973 Solar Occultation of the Crab Nebula Pulsar
U. of Iowa 75-15

C. K. GOERTZ
Plasma in the Jovian Magnetosphere
U. of Iowa 75-16
J. Geophys. Res. [1976]

N. A. SAFLEKOS, K. L. ACKERSON, and L. A. FRANK
Electron Precipitation in the Post-Midnight Sector of the Auroral Zones
U. of Iowa 75-17
J. Geophys. Res. [1976]

PAUL RODRIGUEZ and DONALD A. GURNETT
Correlation of Bow Shock Plasma Wave Turbulence with Solar Wind Parameters
U. of Iowa 75-18
Submitted for publication to J. Geophys. Res.

D. A. GURNETT and L. A. FRANK
Continuum Radiation Associated with Low-Energy Electrons in the Outer Radiation Zone
U. of Iowa 75-19
Submitted for publication to J. Geophys. Res.

J. D. CRAVEN and L. A. FRANK
Electron Angular Distributions Above the Dayside Auroral Oval
U. of Iowa 75-23
Submitted for publication to J. Geophys. Res.

D. A. GURNETT and L. A. FRANK
Electron Plasma Oscillations Associated with Type III Radio Emissions and Solar Electrons
U. of Iowa 75-25
Solar Physics [1976]

D. N. BAKER and J. A. VAN ALLEN
Revised Pioneer 10 Absolute Electron Intensities in the Inner Jovian Magnetosphere
U. of Iowa 75-28

NICOLAOS A. SAFLEKOS, JAMES A. VAN ALLEN, and EMMANUEL T. SARRIS
Entry of Low-Energy Solar Protons into the Earth's Magnetotail
U. of Iowa 75-29
Submitted for publication to J. Geophys. Res.

MICHELLE F. THOMSEN and JAMES A. VAN ALLEN
Galactic Cosmic Ray Intensity 0.99 to 5.26 a.u. from the Sun
U. of Iowa 75-30
Ap. J. [1 June 1976]

JAMES A. VAN ALLEN
High-Energy Particles in the Jovian Magnetosphere
U. of Iowa 75-32
Jupiter, The Giant Planet [Tucson Conference, 18-23 May 1975]

STANLEY D. SHAWHAN
Io Sheath-Accelerated Electrons and Ions
U. of Iowa 75-35
Icarus [1976]

C. K. GOERTZ, D. E. JONES, B. A. RANDALL, E. J. SMITH, and M. F. THOMSEN
Evidence for Open Field Lines in Jupiter's Magnetosphere
Icarus [1976]

L. A. FRANK and K. L. ACKERSON
Examples of Plasma Flows Within the Earth's Magnetosphere
U. of Iowa 75-36

C. K. GOERTZ
The Current Sheet in Jupiter's Magnetosphere
U. of Iowa 75-37
Submitted for publication to J. Geophys. Res.

J. D. CRAVEN and L. A. FRANK
Localized Energization of Polar Cusp Electrons at the Noon Meridian
U. of Iowa 75-38

C. K. GOERTZ
Jupiter's Magnetosphere: Particles and Fields
U. of Iowa 75-39
Jupiter, The Giant Planet [Tucson Conference, 18-23 May 1975]

D. M. YEAGER and L. A. FRANK
Low-Energy Electron Intensities at Large Distances over the Earth's Polar Cap
U. of Iowa 75-40

MARK M. BAUMBACK, WILLIAM S. KURTH, and DONALD A. GURNETT
Direction-Finding Measurements of Type III Radio Bursts Out of the Ecliptic Plane
U. of Iowa 75-45
Submitted for publication to Solar Physics

J. M. WEISBERG, J. M. RANKIN, R. R. PAYNE, and C. C. COUNSELMAN III
Further Changes in the Distribution of Density and Radio Scattering in the Solar Corona in 1973
Submitted for publication to Ap. J. (Letters)

8.0 Research Reports and Publications in Related Fields 1 October 1974 -- 31 December 1975

A. PLASMA PHYSICS

GEORG KNORR and CHRISTOPH GOERTZ
Existence and Stability of Strong Potential Double Layers
Astrophysics and Space Science, 31, 209-223, 1974

DAVID MONTGOMERY, GLENN JOYCE, and LEAF TURNER
Magnetic Field Dependence of Plasma Relaxation Times
Phys. Fluids, 17, 2201-2204, 1974

GEORGE VAHALA, LINDA VAHALA, DAVID MONTGOMERY, and GLENN JOYCE
Comment on "Fluctuations in Guiding Center Plasma in Two Dimensions" by J. B. Taylor and W. B. Thompson
Phys. Fluids, 17, 2298, 1974

DAVID MONGTOMERY
Strongly Magnetized Classical Plasma Models
Proceedings, 1972 Les Houches Summer School of Theoretical Physics [Gordon and Breach, New York, 1974], pp. 431-535

MAGDI SHOUCRI
Linear Instabilities of a Cylindrical Plasma Column in the Guiding-Center Approximation
J Appl. Phys. [January 1976]

M. SHOUCRI and G. KNORR
Linear Instabilities in the Quasistatic Guiding-Center Plasmas
Plasma Physics [1976]

M. M. SHOUCRI
Linear Instabilities in a Non-Neutral Guiding-Center Plasma
Submitted for publication to Plasma Physics

CHIO-ZONG CHENG and GEORG KNORR
The Integration of the Vlasov Equation in Configuration Space
U. of Iowa 75-24
Submitted for publication to J. Computational Physics

MAGDI SHOUCRI, GEORG KNORR, and YEHUDA SALU
Density Gradient Instability of a Guiding-Center Plasma
Submitted for publication to Phys. Rev. Letters

DAVID MONTGOMERY
A B-B-G-K-Y Framework for Fluid Turbulence
Submitted for publication to Phys. Fluids

DAVID MONTGOMERY
The Vortex Street as a Statistical-Mechanical Phenomenon
Submitted for publication to Phys. Rev. Letters

DAVID MONTGOMERY
Plasma Kinetic Processes in a Strong d.c. Magnetic Field
U. of Iowa 75-31
Physica [1976]

CHARLES E. SEYLER JR.
Thermodynamics of Two-Dimensional Plasmas or Discrete Line Vortex Fluids
Submitted for publication to Phys. Fluids

R. W. SCHUMACKER, N. HERSHKOWITZ, and K. R. MacKENZIE
Characteristics of a Large Volume rf Grid Discharge Plasma
Submitted for publication to J. Appl. Physics

K. N. LEUNG, N. HERSHKOWITZ, and K. R. MacKENZIE
Plasma Confinement by Localized Cusps
Submitted for publication to Phys. Fluids

N. HERSHKOWITZ and J. M. DAWSON
Fusion Reactor with Picket Fence Walls
Submitted for publication to Phys. Rev. Letters

RICHARD F. HUBBARD and GLENN JOYCE
Parametric Instabilities Generated by an Energetic Electron Beam
Submitted for publication to Plasma Physics

DAVID FYFE and DAVID MONTGOMERY
High-Beta Turbulence in Two-Dimensional Magnetohydrodynamics
U. of Iowa 75-44
Submitted for publication to J. Plasma Physics

B. ASTRONOMY

JOHN M. RANKIN, R. R. PAYNE, and D. B. CAMPBELL
The Crab Nebula Pulsar: Radiofrequency Spectral Variability
Ap. J., 193, L71-L74, 1974

D. W. RICHARDS, J. M. RANKIN, and G. A. ZEISSIG
Timing Results for Thirteen Pulsars
Nature, 251, 37-39, 1974

GARY SCHMIDT
HeII λ4686 Line Profile Variations in the Spectrum of the Wolf-Rayet Star HD 50896
PASP, 86, 767-768, 1974

STEVEN R. SPANGLER, JOHN M. RANKIN, and STANLEY D. SHAWHAN
Four-Stokes-Parameter Radiofrequency Polarimetry of a Flare from AD Leonis
Ap. J., 194, L43-L46, 1974

M. M. KOMESAROFF, P. M. McCULLOCH, and J. M. RANKIN
Change of Pulse Characteristics of the Vela Pulsar with Frequency
Nature, 252, 210-212, 1974

D. C. BACKER, J. M. RANKIN, and D. B. CAMPBELL
Pulsar Fluctuation Spectra and the Generalized Drifting-Subpulse Phenomenon II
Ap. J., 197, 481-487, 1975

JOHN S. NEFF
Observatory Report
1 October 1973 -- 30 September 1974
BAAS, 7, 311-315, 1975

JOHN D. FIX and JOHN S. NEFF
A Comment on the Spectral Energy Distributions of BA II Stars
M.N.R.A.S. [Short Communication], 173, 83-85, 1975

JOHN D. FIX
C_3 as a Significant Opacity Source in BA II Stars
Ap. J., 203 [January 1976]

STEVEN R. SPANGLER and THOMAS J. MOFFETT
Simultaneous Radio and Optical Observations of UV Ceti-Type Flare Stars
Ap. J. [January 1976]

J. S. NEFF, D. KETELSEN, G. D. SCHMIDT, and J. B. TATUM
Absolute Spectrophotometry of Comet Kohoutek 1973f
I. Column Densities of Cyanogen
Icarus [1976]

ROBERT B. PHILLIPS, JOHN D. FIX, and JOHN S. NEFF
8 Å Resolution Spectrophotometry of the Peculiar A Stars HD 110066 and HD 133029
Ap. J. (Letters), December 1975

WILLIAM A. LANE, JOHN S. NEFF, and JOHN D. FIX
A Measurement of the Relative Reflectance of Pluto at 0.86 Microns
PASP [1976]

ROBERT S. PATTERSON, JOHN D. FIX, and JOHN S. NEFF
Spectrophotometry of R Coronae Borealis during the Minimum of 1974
Ap. J. [March 1976]

STEVEN R. SPANGLER and STANLEY D. SHAWHAN
A Search for Slowly Varying Radio Continuum Emission from UV Ceti Stars
Ap. J. (Letters) [April 1976]

JOHN S. NEFF
Observatory Report
1 October 1974 -- 30 September 1975
BAAS, 8 [January 1976]

STEVEN R. SPANGLER, JOHN M. RANKIN, and STANLEY D. SHAWHAN
430 MHz Polarimetry of Flares from UV Ceti-Type Stars
Submitted for publication to Ap. J.

J. K. DAVIDSON, J. S. NEFF, and D. C. ENEMARK
A Sky Compensating Filter Photometer
U. of Iowa 75-41
Submitted for publication to PASP

JOHN D. FIX and STEVEN R. SPANGLER
Spectrophotometry of the Flare Star BY Draconis
U. of Iowa 75-43
Submitted for publication to Ap. J. (Letters)

STEVEN R. SPANGLER
Radio Sources in the Vicinity of Flare Stars
Submitted for publication to PASP